for each of the planets and their moons, here there are only three: one for Mars and the Earth's Moon, one for the Earth–like planets and one for the Jovians. In a chapter entitled "Rings, Moons, and Pluto," only the Galilean satellites and a few other representative objects get much attention. The mathematics of the magnitude scale, which gives nonscience students more trouble than inspiration, is brushed off in a few brief paragraphs.

This emphasis on concepts rather than objects enables the authors to unite topics that might be scattered throughout a more conventional book. Aspects of asteroids, meteors and planetary atmospheres appear in a chapter on the formation and evolution of the Solar System. Various methods of measuring stellar distances are collected in a single chapter. Conversely, some objects receive more extended treatment: The study of the Sun gets two chapters, one on its visible surface and one on its interior structure and energy supply. There is a separate chapter on black holes (just because they are so interesting) and a final chapter on the formation of life and the search for extraterrestrial intelligence.

Inset throughout the text is an adequate but not excessive number of informative asides. Short, informative biographies of astronomers from Edmond Halley to Edwin Hubble highlight the active role of the observer and theorist. Several sections, called "Making Connections," deal with astronomy in poetry, history and art. There are observational activities that students can carry out with the naked eye or a small telescope. Most chapters end with a set of activities that can be done indoors, with an interactive CD-ROM included with the text.

The coupling of the book with a CD-ROM may be a sign of things to come. The future of textbooks, some say, is in multimedia, probably delivered through the World Wide Web. It's an attractive idea. Trying to keep instructional materials up-to-date in a field like astronomy is impossible, especially with the long production schedule needed for an "off-line" textbook. And although *Voyages* has a full treatment of the planets newly discovered around nearby stars, the Mars Pathfinder mission came too late for inclusion. Still, readers can easily find the latest information by following one of the links in the extensive list of Web sites included in one of the appendices.

In the long run, though, textbooks may well escape cyber-obsolescence by providing students with an authoritative and attractive interpretation of important ideas, by distancing readers from the immediacy of Internet discourse. The Web, as we all know, assaults us with data, but a good textbook like *Voyages Through the Universe* can help us clothe bare facts with understanding.

Laurence A. Marschall
Gettysburg College
Gettysburg, Pennsylvania

The Fire Within the Eye: A Historical Essay on the Nature and Meaning of Light

David Park
Princeton U. P., Princeton, N.J., 1997. 337 pp. $49.95 hc
ISBN 0-691-04332-9

I would describe David Park's *Fire Within the Eye* somewhat oxymoronically as a scholarly popularization: On the one hand, it is intended for a general audience; on the other, it purports to be based on recent scholarship in the history of optics. It should therefore be evaluated on two levels: how well it serves as a general historical overview and how well it reflects current scholarship in the history of optics. Let's start at the more general level.

My first observation is that, subtitle notwithstanding, this is not just a historical essay. It is an extraordinarily broad-ranging survey of thought about light, color and vision from antiquity to the present. As such it is ambitious in the extreme, not only because of its vast chronological scope but also because of the wide net Park casts in grappling with changing conceptions about the nature and meaning of light. So wide is his net in fact, that he snags it—notably on the "meaning" of light—for in raising that issue, he crosses into religious territory (Jesus as light, light as the first creative principle and so on), as well as into that of art and literature.

Given the rather daunting challenge he has posed for himself, Park has done a fairly good job of steering a narrative course. I say "fairly good," because there are still problems. For one thing, the study sometimes lacks focus, particularly toward the beginning, because of shifts from scientific to cultural perspectives on light. This blurring of focus is exacerbated by Park's tendency to dwell on biographical details that have no evident bearing on the subject at hand. As examples I cite his accounts of Kepler (whose cosmological ruminations seem essentially irrelevant to his "discovery" of the retinal image) and Galileo (whose Copernican convictions and telescopic observations had only the most oblique impact on the development of light theory during the 17th century). Such biographical divagations, coupled with the attendant lack of focus and a tendency toward somewhat facile generalizations, give Park's book the feel at times of an undergraduate textbook survey in which light serves more as an occasion for than the central subject of the narrative.

As to how well Park incorporates current scholarship in the history of optics into his account, I would again have to give qualified approval. A few examples will suffice to clarify my reservations. First, although he acknowledges a profound debt to David Lindberg for his understanding of medieval and Renaissance visual theory, Park either misses (or refuses to take to heart) the implications of Lindberg's account of punctiform analysis. As a result, he misconstrues al-Kindi's theory of visual radiation; al-Kindi had visual radiation emanate from the corneal surface rather than from within the eye (as Euclid and Ptolemy had it). Having missed this point, Park then misses the real point of Alhazen's theory of visual selection at and by the surface of the crystalline lens. He compounds the problem by wrongly attributing to Alhazen the idea that the crystalline lens lies at the very center of the ocular globe (a mistake that presumably follows from his having relied on an illustration provided by Alhazen's Renaissance editor, Friedrich Risner, rather than one from Alhazen himself). Also, by ignoring some of the dynamic implications of post–Ptolemaic ray theory, Park fails to see how critical the principle of economy was in the explanation of refraction before the time of Pierre de Fermat. (It is, by the way, misleading in the extreme to characterize Hero of Alexandria's economy principle as one of time, as Park does on page 184.)

Up to now, I have been praising this book with faint damns, but let me mitigate my criticism with some positive observations. First, as a historical survey, Park's study is far superior to its closest rival—Vasco Ronchi's *Storia della luce* (1939; English translation, Heinemann, 1970)—in great part because of Park's sensitivity to ulterior epistemological issues. Second, the book's errors are few and not particularly significant; much of what I have taken issue with here is a matter of interpretive standpoint rather than of factual orthodoxy. Third, it is only fair to point out that as an "essay," this study is quite personal in its goals and perspectives. It therefore reflects a subjectivity that is somewhat jarring to a professional historian used to ana-

lytic "objectivity." This, in short, is not the book *I* would have written. But then, why should it be?

A. Mark Smith
University of Missouri—Columbia

Introduction to Bioengineering

Edited by Stanley A. Berger, Werner Goldsmith and Edwin R. Lewis
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ISBN 0-19-856516-X

Bioengineering, sometimes called biomedical engineering or bioelectronics, among other things, had its historical beginnings in antiquity, as for example, the ancient Greek use of electric discharges from eels to treat certain disorders. A more recent example is the invention of the stethoscope in 1819 by René Théophile Hyacinthe Laënnec, the father of chest medicine, when a demure patient refused to allow him to set his ear directly upon her chest to examine her chest sounds, the common practice of the time. The field grew rapidly after World War II, when discharged servicemen and women flocked to colleges and universities, as did many scientists and engineers who had worked in industry and government laboratories during the war.

Among the latter were those who had been educated in the physical sciences and had studied on their own the biology they needed to pursue the bioengineering studies they proposed to undertake. The next-generation engineering students had more opportunity for formal training; they had access to engineering classes dealing with the biology pertinent to their thesis topics. The field has now progressed to the point where students can enroll in undergraduate and graduate bioengineering degree programs, complete with laboratory courses, texts and tenured faculty.

Introduction to Bioengineering, edited by Stanley A. Berger, Werner Goldsmith and Edwin R. Lewis, results from such a program, initiated about 1975 at the University of California, Berkeley, as a two-semester course. It comprises 14 chapters by 19 authors representing mechanical, electrical, chemical and nuclear engineering, and orthopedics and human biodynamics. The book is intended to be at the intermediate undergraduate level, meaning that the student is expected to have already taken basic university courses in mathematics, physics and chemistry. The student coming from the life sciences, without the first-level